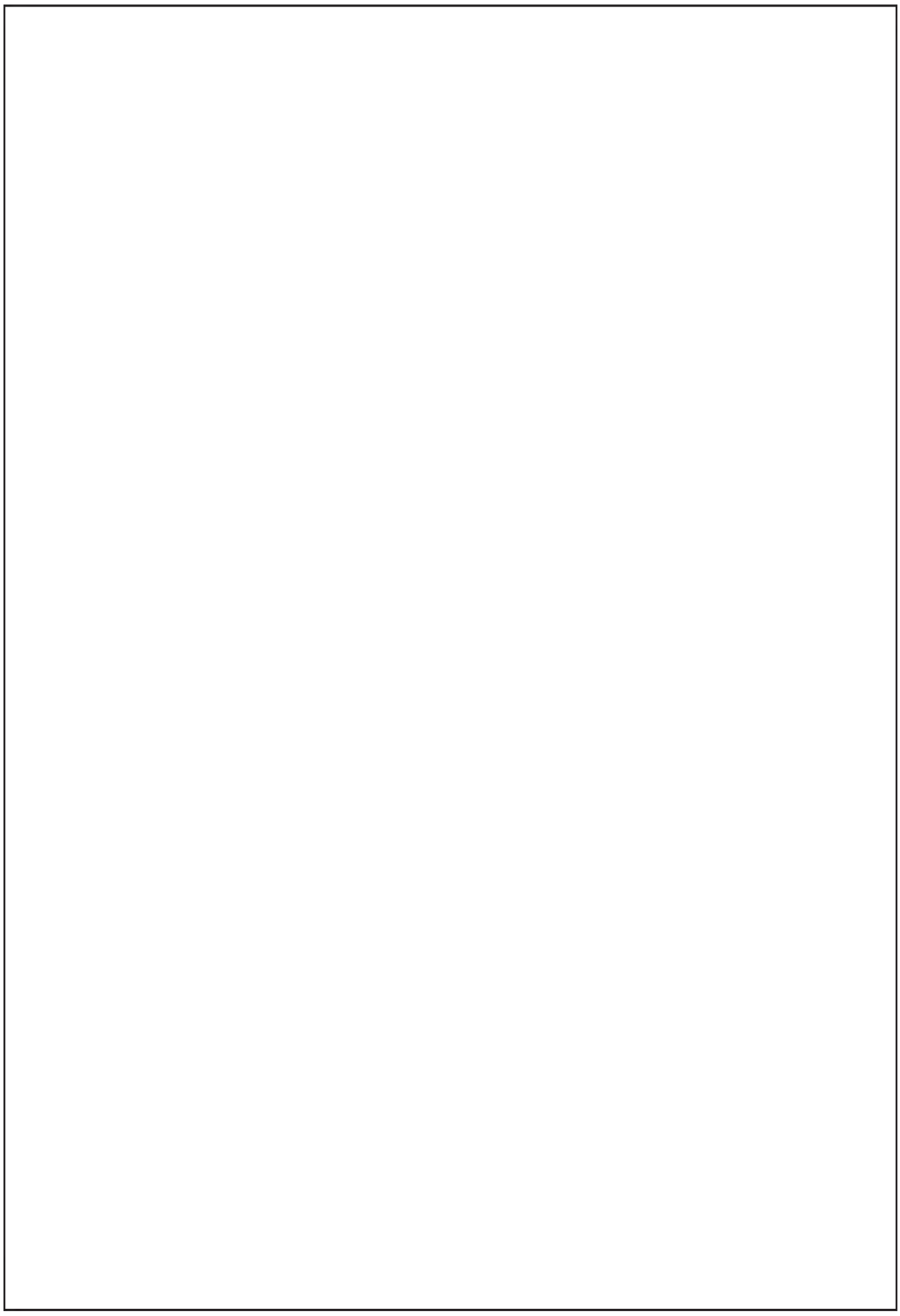


Role of Demand and Supply Shocks in Driving Inflation: Case Study of Pakistan

Mahmood ul Hasan Khan[1]
Dr. M. Nadeem Hanif[2]

Abstract

Generally, inflation refers to a reduction in purchasing power per unit of money and is considered a consequence of negative trends in monetary activity. As a number of factors may lead to inflation in an economy, this study attempts to measure the relative significance of structural shocks in explaining inflation. Monthly time series data is used on key macroeconomic variables of Pakistan from July 1992 to June 2011, and structural vector auto-regressions (SVAR) to understand the role of supply and demand shocks as key drivers of inflation. Long-run restrictions according to standard aggregate demand and aggregate supply framework are employed to identify structural shocks in the system. The results indicate that inflation follows a sluggish time path in response to supply shock as compared to demand shock of nominal nature. Specifically, around 75 percent of long-run impact of supply shock on inflation is realized over a period of one year horizon as compared with 90 percent for demand shock. In terms of relative significance, supply side disturbances explain 48 percent of variation in inflation over the estimation period. Within demand side, nominal shocks are relatively more important than the real demand shock. The share of real demand shock was around 10 percent, while the reaming 42 percent was attributed to nominal shock. These results suggest that in addition to monetary factors, supply side disturbances should be taken into account for better understanding of and 'handle' on inflation in Pakistan.

Keywords: *Demand shock, inflation, long run restrictions, SVAR, supply shock*

1. Introduction

The monetarist view that "inflation is always and every where a monetary phenomenon" is widely accepted in economic literature as a long-held proposition. Accordingly, monetary policy framework in advance economies is primarily designed around the monetarist view. Success of central banks in taming inflation over the last three decades (from early 1980s onwards) also lends credence to the monetarist view at least in developed world. Rising popularity of inflation targeting in advanced countries over the past two decades also indicates that central banks have the ability to control inflation.

In spite of above-mentioned developments, the structuralists highlight the role of supply side factors (i.e., supply bottlenecks and structural rigidities in the economies) in explaining inflation. This view is of great importance for developing countries like Pakistan where the fragmentation among different sectors of the economy and demand-supply gaps within the sectors seems to be playing an important role in determining inflation. Bilquees (1988) was the first to explicitly test the monetarist and structuralist views of inflation in case of Pakistan. She finds that debate between the monetarists and the structuralists on inflation is very 'relevant' for developing countries like Pakistan. She also concludes that in addition to the monetarist factors, structural issues should be taken into account for better understanding of inflation in Pakistan. Khan and

[1] Mahmood ul Hasan Khan is Economist, State Bank of Pakistan, Karachi, mhkhan45@hotmail.com
[2] Dr. M. Nadeem Hanif is Senior Research Economist, State Bank of Pakistan, Karachi, nadeem.hanif@sbp.org.pk

Schimmelpfennig (2006) also found the role of supply side factors in explaining short-run dynamics of inflation in Pakistan. Besides these studies, State Bank of Pakistan (SBP) flagship publications also acknowledged the importance of supply disruptions in explaining inflationary pressures in the economy quite often, if not regularly.

In fact, Pakistan's economy has witnessed an average inflation of 8.7 percent per annum during the last two decade compared to 8.2 percent over the last five decades. In recent years, it has been in double digits, and average annual inflation turns out to be 11.9 percent during FY08-FY11. The SBP inflation projections for FY12 are also in the range of 11.0 to 12.0 percent (SBP, 2012). It is important to note that SBP has continuously striving to improve its monetary policy framework over the same period, especially during the last five years. However, the improvement in monetary policy framework has come at a time when the country has been hit by a number of supply shocks, including massive rise in international oil prices in 2008, devastating floods in 2010, and heavy rains in 2011. On the other hand, the demand side factors continued to gain strength from persisting deficits in the economy, especially the fiscal deficit.

Despite highlighting these issues and persistence of inflation, there is hardly any effort to quantify the impact of supply shocks on inflation in Pakistan. In these settings, this study attempts to explore dynamics of inflation in Pakistan. Specifically, the study is focused: (a) to disentangle and quantify the role of unanticipated shocks stemming from demand and supply sides on inflation; (b) to estimate the time period required to realize the full impact of demand and supply shocks on inflation; and (c) to understand the time path followed by inflation in response to demand and supply shocks.

2. Literature Review

Inflation is one of the widely explored areas of economic research. General public is the victim of inflation as persistent rise in prices decreases the value of their financial assets and the purchasing power. Moreover, sudden increase in inflation distributes income away from savers to the borrowers. While there is no disagreement on the ultimate impact of inflation, the causes of inflation at least in the short run remain a point of debate among the economists. Demand-pull and cost-push theories of inflation are parts of all macroeconomics text books, and widely discussed in economic literature. Relatively less known is the structural inflation theory, which states that changes in inflation are inextricably linked with changes taking place in the structure of the economy. Particularly, as the developing countries move towards higher level of development, the changes in underlying structure of the economy (i.e., from agriculture sector towards industrial and services sectors) exert a profound effect on inflation in the economy. This view is of special interest for developing countries like Pakistan, where the changes in economic structure and level of overall development are quite visible.

Literature available on inflation in case of Pakistan indicates that most of the studies focused on monetarist model of inflation, i.e. traditional quantity theory of money. For example, Kemal (2006) used monetarist framework to examine "whether inflation in Pakistan is a monetary phenomenon or not". The author used quarterly data from Q1-1975 to Q4-2003 to examine long-run and short-run relationships between money and inflation. His results indicate that quantity theory of money holds in the long-run. In other words, the author finds evidence in favor of monetary phenomenon in the long-run.

In another study, Khan and Schimmelpfennig (2006) findings also support the monetarist view as a long run proposition. These authors used monthly time series data from January 1998 to June 2005 to "examine the relative importance of monetary factors and structuralist supply-side

factors for inflation in Pakistan". Their stylized model includes credit to private sector (CPS), money supply (M2) and nominal exchange rate, while support price of wheat was used to proxy supply shock. They find that monetary factors (CPS and M2) have played a dominating role in driving inflation during the period of analysis, with a time lag of about one year. The authors also concluded that impact of change in wheat support price was visible only in the short run. It implies that supply shocks do play an important role in determining inflation in the short-run. The study on the subject by Bilquees (1988) suggests that the debate between the monetarists and the structuralists on inflation is very 'relevant' for developing countries like Pakistan. She also concluded that structural issues should be taken into account in addition to the monetarist factors, for better understanding of inflation in Pakistan.

Khan (2008) also partially discussed this, while analyzing the impact of unanticipated monetary shock on inflation. The author used monthly data from July-1991 to September-2006, and SVAR technique to study the impact of monetary shock on inflation. The study concludes that nominal shock turns out to be the biggest contributor to inflation having share of around 50 percent in explaining changes in inflation. Detailed results also indicate that the share of supply side disturbance was around 25 percent over the estimation period.

In this backdrop, although this study closely follows the methodology of Khan (2008), its contribution to literature is two-folds. First, to include changes in real exchange rate in the base model allow for taking into account the impact of developments taking place at international level. Moreover, it seems more relevant as the Pakistan's economy is primarily linked to rest of the world through trade lineages. Capital account of the country is yet to be made fully convertible, where interest differential across countries play an important role. Secondly, it provides evidence on the subject by using the latest available information on key variables of interest.

3. Research Methodology

3.1 Structural VAR and Identification Restrictions

To analyze the sources of variation in inflation, the study makes use of the SVAR techniques. Technically, SVAR is essentially based on the reduced form vector auto-regression (VAR), where each variable in the system is expressed in terms of its own lagged values and lags of all other endogenous variables in the system. The dynamic effect of exogenous shocks on endogenous variables is identified by imposing minimum number of restrictions on the correlation structure (of residuals) obtained from the reduced VAR. In matrix form, VAR model reduces to the following functional form.

$$R(L)Y_t = e_t \;\; Where\; E(e_t) = 0 \; and \;\; E\left(e_t e_t^{'}\right) = \Omega_e and\; E\left(e_t e_{t+s}^{'}\right) = 0 \; \forall \; s \neq 0$$

Where Y_t represents a vector of endogenous variables; *R(L)* is a polynomial matrix in L, which is a lag operator that takes into account the number of lags of endogenous variables included in the system; and e_t is a vector of innovations. If the endogenous variables in VAR are weakly stationary, it can be written in the form of vector moving average (VMA) as follow.

$$Y_t = R(L)^{-1} e_t \;\; or\; Y_t = A(L) e_t \; where\; A(L) = R(L)^{-1} \quad (2)$$

The innovations may be uncorrelated to their own lagged values, but they are likely to be contemporaneously correlated. It implies that Ω_e matrix may not be an identity matrix. In other words, it is difficult to attach an economic interpretation to response function from the above

specification due to unspecified correlation structure of variance covariance matrix of the innovations.

The VMA, in which structural shocks are independent of each other as they are economically distinct shocks, can be expressed as follow.

$$Y_t = B(L)\varepsilon_t \ \ Where\ E(\varepsilon_t) = 0\ and\ \ E\left(\varepsilon_t \varepsilon_t'\right) = \Omega_\varepsilon = I\ and\ E\left(\varepsilon_t \varepsilon_{t+s}'\right) = 0\ \forall\ s \neq 0 \quad (3)$$

Comparison of equation (2) and equation (3) implies that:

$$Y_t = B(L)\varepsilon_t = A(L)e_t \quad (4)$$

Evaluation of equation 4 for contemporaneous correlation (i.e. at $L = 0$) will yield the following expression;

$$B(0)\ \varepsilon_t = \mathrm{A}(0)\ e_t \quad (5)$$

As we know, $A(0)$ is an identity matrix due to reduced form nature of the VMA. Therefore, the above expression can be rewritten as follow.

$$B(0)\ \varepsilon_t = \mathrm{A}(0)\ e_t \quad (6)$$

If $B(0)$ is an invertible non-singular matrix, structural innovations will be linearly linked to innovations from the reduced form VAR. And, information on invertible matrix $B(0)$Would allow extracting information on structural innovations from the reduced form innovations. However, this is not straight forward as the relationship between variance of reduced and structural innovations provides the flowing expression.

$$\Omega_e = B(0)\Omega_\varepsilon B(0)'or\ \ \Omega_e = B(0)IB(0)'\ or\ \ \Omega_e = B(0)B(0)'$$

Although Ω_e in above expression can be estimated from reduced form model, it does not allow to recover all the parameters in matrix $B(0)$. This problem is resolved by imposing restrictions on the correlation structure among the variables.

In literature, three different approaches are widely employed to disentangle the impact of exogenous shocks. The most famous approach is Cholesky decomposition: a statistical method to restrict coloration structure in such a way that allows estimating response functions of the endogenous variables to the exogenous shocks. The biggest problem with this approach is that the response functions are sensitive to the change with reference to the endogenous variables. Another problem with this approach is the restriction on the contemporaneous correlation, while the endogenous variables generally entail a feedback effect from other variables.

Keeping these issues in mind, identification restrictions in this paper are derived from the long run impact of different shocks on the inflation. This methodology was first developed in Blanchard and Quah (1989), and was further refined in Quah (1992), Blanchard and Quah (1993) and Quah (1995), will be referred as BQ methodology in this study. This methodology is preferred on other approaches as: (a) there is little disagreement among the economists on the long-run impact of exogenous shocks on macroeconomic variables like inflation; and (b) this approach allow the analysis of short run dynamics as these are freely determined by data; and (c) it allows disentangling the impact of exogenous shocks on endogenous variables by identifying structural innovations

according to the reference model.

The evaluation of equation (4) for long run multipliers (i.e. L=1) will yield the matrix. $B(1)$ The long run restriction that the structural shock 'j' does not affect the level of endogenous variable 'i' in the long run implies that the element $B(1)_{i,j}$ of $B(1)$ is restricted to be zero.

3.2 Identification of Restrictions

Structural restrictions in this study are derived from aggregate demand (AD) and aggregate supply (AS) model. The study will make use of three key macroeconomic variables, including industrial production index (IPI), real effective exchange rate (REER), and consumer price index (CPI). These three variables will allow disentangling the impact of supply, real demand and nominal demand shocks on inflation in the economy.

Long-run vertical AS curve in the model implies that only supply shocks of permanent natures can affect the long-run level of output. It implies that both the real demand and nominal (monetary) shocks will have short-run impact on the level of output, while having no long-run impact on output. Similarly, the nominal shock will have no effect on the long-run real demand, while it will have positive impact in the short run. However, nominal demand in both short and long-run will be affected by both supply and real demand shocks in the system.

As structural VARs are generally sensitive to the nature of restrictions imposed for identifying structural shocks, an alternative specification is obtained by replacing (DRER) in the base model with changes in real interest rate (DRIR).

4. Data and Descriptive Analysis

The study uses IPI as a proxy to real output in the economy. Although industrial sector accounts for almost a 20 percent of Pakistan's GDP, it is perhaps the single most used variable in high frequency to represent change in production activities in the economies. Moreover, it is a very good proxy of economic activities in the country as IPI has strong backward and forward linkages in the economy. Log is applied to the index as it will allow interpret changes in index as a monthly growth rate of industrial sector. The unit root tests reveal that log IPI is non-stationary at level and is integrated of order one (Table 1).

Log transformation is also applied to the index of real effective exchange rate. Theoretically, index of REER should be mean reverting as it is difficult for a country to keep its currency over or under value in real term for a long period. Standard tests of unit root indicate that we fail to reject the presence of unit root in the REER at 5 percent level of significance. The first difference of the index is stationary (Table 1).

Table 1: Results of Unit Root Tests

	ADF Value*	PP*
Level		
Log of IPI	-0.4572(12)	-0.8815
Log of CPI	0.7219(3)	0.9226
Real Interest Rate	-3.3823(2)	-6.2437
Long of Real Exchange Rate	-2.3086(1)	-2.0857
First Differences		
DIPI	-4.3747(11)	-31.3977
DCPI	-5.7068(2)	-12.6206
DRIR	-16.4601(1)	-23.1833
DER	-12.0775(0)	-11.8009

*Critical values for ADF test at 1 & 5% level of significance are -3.4595 and -2.8743 respectively. Similarly, critical values for PP test at 1 & 5 % level of significance are -3.4592 and -2.8741 respectively.

For real interest rate calculation, 6-month T-bills cut-off rate were used for interest rate as it is one of the key policy rate in the country. Many studies have used this rate to proxy policy rate, for example Khan (2008), Qayyum (2005). This rate is adjusted to YoY inflation (based on consumer price index) to obtain RIR in the economy. Theoretically, RIR in the economy, like real exchange rate, should also be mean reverting. Both

ADF and PP tests indicate that the series is stationary. However, the first difference of the series is used as it leaves no room for contemplating about the non-stationarity.

Finally, the selection of consumer price index is straightforward as what leads to changes in CPI (inflation) is the main motivating factor for this study. Log transformation is applied to CPI as change in log CPI can be interpreted as inflation. Log CPI is also integrated of order one over the sample period as first difference of log CPI is stationary (Table 1). It is important to note that daily consumer price index (DCPI) will denote monthly inflation.

5. Estimation and Results

Following the selection of variables for SVAR in line with the reference economic model and identification of shocks, first step is to estimate a simple VAR in reduced form. A VAR comprising on three endogenous variables and 11 dummy variables was specified to explicitly model seasonality because of monthly data.

As for number of lags in VAR is concerned, search for optimal lag selection was initiated by specifying maximum of 15 lags: number of lags higher than one year and takes into account first quarter of second year as well. Test statistics on information criteria indicate that Schwarz (SIC) and Hannan-Quinn (HQ) information criteria are in favor of selecting one and two lags respectively, while all other tests favor 12 lags for the system. The Wald tests of excluding one lag at a time also indicate the significance of 12^{th} lag. Keeping the results of these tests and monthly nature of data in mind, 12 lags for VAR were selected.

Table 2: Long-run Multipliers Matrix
Monthly growth Rates

	Shocks		
Variable	Supply	RealDemand	Nominal
IPI	0.0281*	0.0000	0.0000
RER	-0.0008	0.0151	*0.0000
CPI	-0.0180	0.0057	*0.0100*

* indicates statistical significance at 1 percent

Diagnostic tests on the residuals of individual regressions indicate no evidence of serial correlation and regressions seem to be well- specified. The VAR also satisfies the stability condition as none of the inverse roots lies outside the unit circle.[1] As for modeling seasonality is concerned, dummy variables confirm the presence of seasonality in daily industrial production index (DIPI) and DCPI. Specifically, 8 out of 11 dummy variables were statistically significant in the DCPI regression, while the 5 out of 11 are significant for DIPI regression. None of the dummy variables turned out to be significant in regression for DRER.

5.1 Structural Decomposition

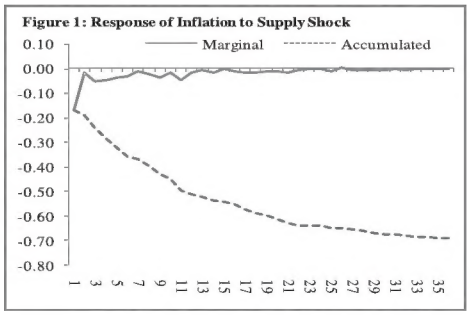
Once the reduced form VAR has been selected, the next step is to specify restrictions for the matrix of long-run multipliers. The imposition of structural restrictions yields the matrix of long-run multipliers (Table 2). The results indicate that a positive supply shock (equal to monthly growth rate of 2.5 percent) will increase monthly growth of industrial production by 2.8 percent. More importantly, supply shock will also reduce inflation by 1.8 percent over the long horizon. In other words, a 100 bps positive supply shock reduces inflation by 72 bps over the estimation period. While there is no specific study in our knowledge to compare these results in case of

Pakistan, the direction of relationship is the same as postulated by the economic theory.

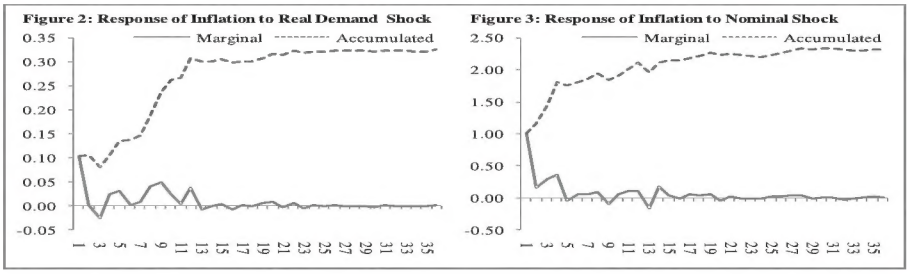
The results also indicate that real demand shock of 1.7 percent will have a positive impact on inflation in the long run. The nominal shock (which could be an increase in money supply) will also have a positive long run impact on inflation. These results are important in a sense that inflation is affected both by supply and real demand shocks in addition to nominal shock. It implies that inflation in Pakistan cannot be termed as a "monetary phenomena".

5.2 Short Run Responses

The biggest advantage of using long-run restrictions in line with BQ1989 is its ability to allow the analysis of short-run dynamics without imposing restrictions on the contemporaneous correlations. Although the model provides short- run responses of all three variables in the system, here the time path of inflation is focused in response to various shocks only. Moreover, all shocks have been adjusted to 100 bps for the ease of interpretation. Figure 1 depicts that a 100 bps supply shock will have negative contemporaneous effect on inflation of 17 bps and it gradually recedes over time. The accumulated response function indicates that around 75 percent of long-run impact of supply shock on inflation occurs during the first year of the shock. It reaches to 85 percent during the 18 months. The figure also shows that it takes almost three years to complete the process as the accumulated impact becomes almost flat as time reaches to 3 years (36 months).



Compared to supply shock, 100 bps shock to real demand will have a positive impact on inflation. It increases inflation by 10 bps during the first month of the shock (Figure 2). Moreover, over 90 percent of the impact of real demand shock on inflation takes place just in one year and it dies out completely within 24 months. It implies that pass-through from real demand shock to inflation is faster compared to the supply shock. This is in line with theoretical expectations as increase in demand puts immediate pressure on prices, while the supply shock takes slightly more time to effecting overall inflation in the economy.



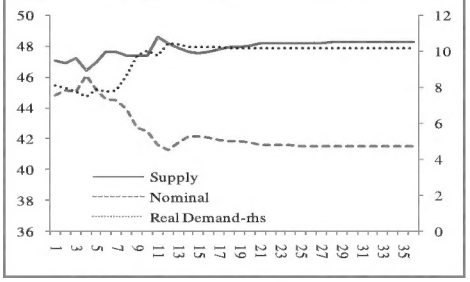
Finally, nominal shock has also positive effect on inflation in the economy. Specifically, a nominal shock of 100 bps will ultimately lead to more than 200 bps increase in inflation. The pass-through of nominal shock is also quicker as compared to the supply shock, while it is approximately same as the real demand shock. Time path of inflation in response to nominal shock suggests that around 90 percent of the impact is realized during the first year of the shock (Figure 3). And, it reaches more than 95 percent in first six quarters.

5.3 Relative Importance of Shocks

The relative significance of shocks is analyzed by using the concept of variance decomposition. Although the SVAR estimations allow to decompose variation in all endogenous variables used in estimation, the study only focuses on inflation, while the results for other variables are not reported for the sake of brevity. The results indicate that supply shocks explained approximately 48 percent of variation in inflation over the last two decades, while the remaining 52 percent is attributed to demand shocks (Figure 4). Within demand shocks, the share of real demand shock is around 10 percent, while the nominal shock accounted for 42 percent.

The roots of this relatively high importance of supply shocks could be traced to the composition of CPI baskets. Before the recent revision, the food component alone carried a weight of 40.3 percent in CPI basket. Fuel and lightening group accounted for another 7.3 percent. Given the country's dependence on oil imports, changes in oil prices in international market is a supply shock to the economy. In these setting, the relative importance of supply shock seems to be inline with the CPI basket.

Figure 4: Decomposition of Variation in Inflation (% share)

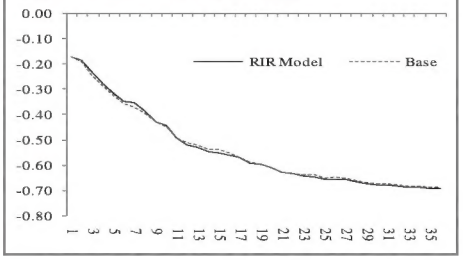


Interestingly, the role of supply shock in our study is considerably higher than reported by Khan (2008), i.e. around 28 percent. One of the possible explanations could be the increased importance of supply shocks over the estimation period. Specifically, the country has witnessed at least three major supply shocks over the last five years, while Khan (2008) used data up to September 2006. Moreover, supply disruptions dues to law and order situation have also increased during the past five years.

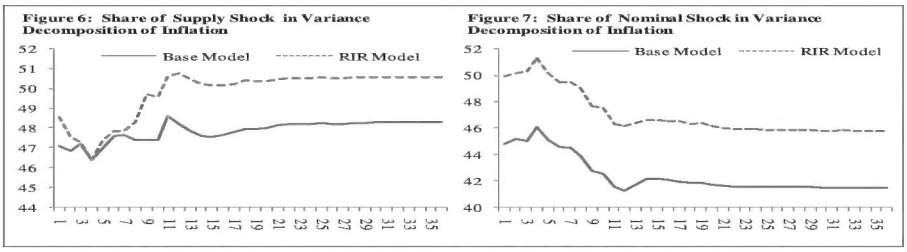
6. Sensitivity Analysis

To explore sensitivity of SVAR results to the choice of variables and nature of restrictions, the DRER was replaced with DRIR. In AD/AS framework, both variables are subject to same type of restrictions and are endogenous within the system. It implies that both variables should be able to identify supply shock in clear manner, while the identification of real demand from nominal shock will be subjected to some variation as the time path of DRIR may differ from that of DRER in response to real demand and nominal shocks.

Figure 5: Response of Inflation to Supply Shock



Although the estimation process is same as that of the base model, the focus was only on comparing the results of the key variable, i.e., inflation. Inflation response function follows almost exactly the same path in both the models (Figure 5). It means that supply shock in both models has been correctly identified in relation to inflation. Time path of inflation also remained almost unchanged in relation to real aggregate demand and nominal shocks. However, the magnitude of responses differs because DRER and DRIR are measured in different units.



As for relative importance of different shocks is concerned, Figure 6 indicates that share of supply shock has slightly increased to 50 percent against 48 percent in the base model. At the same time, there is some increase in the share of nominal shocks in explaining inflation in the economy (Figure 7). This negligible variation in relative importance reflects the robustness of the results discussed in the previous sections.

7. Conclusion

This study explores the role of supply and demand shocks in driving inflation in case of Pakistan by using monthly time series data from July 1992 to June 2011 and SVAR methodology. Long-term restrictions for the identification of structural shocks are derived from a standard AD/AS model.

The results indicate that a positive supply shock (equal to monthly growth rate of 2.5 percent) will reduce inflation by 1.8 percent over the long horizon. However, its pass through to inflation is sluggish as compared to the time required for demand shock to effect inflation. The short run dynamics indicate that around 75 percent of long run impact of supply shock on inflation occurs during first year of the shock and it reaches to 85 percent during the 18 months.

In terms of relative importance, the supply shocks explain 45 to 50 percent of variation in inflation over the period of analysis. The robustness of the results is checked by carrying out sensitivity analysis i.e., by replacing real exchange rate with real interest rates. The results indicate no significant difference in the relative importance of different shocks in explaining variation in inflation. The composition of CPI basket also provides some indication as the food group accounted for 40.3 percent of the consumer basket used to calculate inflation until June 2011.[2]

While this paper made an important contribution by quantifying the role of supply and demand shocks as key drivers of inflation over the last two decades, the analysis can be extended to identify the nature of supply and demand shocks. Specifically, the paper can be extended to disentangle the impact of supply shocks emanating from domestic supply bottlenecks and developments taking place outside the country. Similarly, the efforts can be exerted to explore the nature of demand shocks. The researcher could also try to separate the role of monetary and fiscal policy changes in explaining variation in inflation. Last but not the least a full-fledged sensitivity analysis can be carried out by changing different variables in SVAR specification. Research on these lines will help in further refining the results of this study, and will be of great value for the policy managers.

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End Notes

[1] Details on the value of the parameters could be obtained from the author.

[2] It may be noted that CPI basket has recently been revised to new base of 2007-08. The share of food group and non-alcoholic beverages in new CPI basket has slightly declined to 34.83 percent. In true sense, this may not be directly comparable with the food group is the previous basket due to redefining the groups in new basket, it is perhaps the most comparable food group across baskets from research point of view.